UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex parte DAVID RUSSELL EVANS

Appeal No. 2005-1220
Application No. 09/270,606

ON BRIEF

Before KIMLIN, WALTZ and KRATZ, Administrative Patent Judges.
KRATZ, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on appeal from the examiner's final rejection of claims 1-20, which are all of the claims pending in this application.

BACKGROUND

Appellant's invention relates to a chemical-mechanical polishing (CMP) process. An understanding of the invention can be derived from a reading of exemplary claims 1 and 13, which are reproduced below.

> 1. An method of fabricating an integrated circuit using CMP comprising:
> providing a substrate with an overlying silicon dioxide layer, and without any dummy structure;
> forming a CMP slurry containing cerium oxide;
> adding a slurry modifier to the slurry, wherein the slurry modifier combined with CMP slurry polishes

low structure areas at a substantially zero rate and polishes high structure areas at a rate approximating a blanket polishing rate without the use of a dummy structure; and

polishing the silicon dioxide layer without polishing any dummy structure using the modifier-containing slurry, whereby the low structure areas are polished at a substantially zero rate and the high structure areas are polished at a rate approximating the blanket polishing rate without using any dummy structure.

13. A method of fabricating an integrated circuit using CMP comprising:

providing a substrate with an overlying silicon dioxide layer, and without any dummy structure such that the silicon dioxide layer forms low structure areas and high structure areas, without any dummy structure;

forming a CMP slurry having a high structure polishing rate lower than a blanket polishing rate;

adding a slurry modifier to the slurry to produce a modified slurry that polishes high structure at a rate approximating the blanket polishing rate; and

polishing the high structure areas of silicon dioxide, whereby the high structure area are polished at a rate approximating the blanket polishing rate without using any dummy structure.

The prior art references of record relied upon by the examiner in rejecting the appealed claims are:

Kodera et al. (Kodera)	5,445,996	Aug. 29, 1995
Grover et al. (Grover)	5,759,917	Jun. 02, 1998
Burke et al. (Burke)	5,934,978	Aug. 10, 1999

Claims 1-20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kodera in view of Grover and Burke.

We refer to the brief and reply brief and to the answer for a complete exposition of the opposing viewpoints expressed by appellant and the examiner concerning the issues before us on this appeal.

OPINION

Having carefully considered each of appellant's arguments set forth in the brief and reply brief, appellant has not persuaded us of reversible error on the part of the examiner. Since we are in substantially complete agreement with the examiner's application of the prior art, as well as the examiner's disposition of the arguments and evidence raised by appellant in the brief, we will affirm the examiner's rejections for substantially the reasons set forth in the answer. We add the following for emphasis.

Appellant furnishes six separate claim groups: (i) claims 1-3, 5, 6, 10 and 11; (ii) claims 4, 7-9, 12, 16; (iii) claims 13 and 14 and (iv) claims 17-19; (v) claim 15; and (vi) claim 20 (brief, pages 4 and 5). For the four groupings involving more than one claim, appellant states that the claims of each such grouping stand or fall together. Consequently, we select claims 1, 4, 13 and 17 as the respective representative claims on which we shall decide this appeal as to appellant's claim groups (i)-

(iv), as identified above. Claims 15 and 20 are separately identified as standing or falling alone. Consequently, to the extent appellant has clearly stated that the latter claims do not stand or fall together and have also argued each claim separately with respect to any particular ground of rejection consistent with 37 CFR § 1.192 (c)(7) and (8), as in effect at the time of the filing of the briefs[1], we shall treat those claims separately.

We start with claim 1, which is representative of the Group (i) claims.

Appellant does not dispute that Kodera is directed to a method of fabricating an integrated circuit semiconductor device using chemical mechanical polishing (CMP). Kodera teaches that a substrate with an overlying silicon dioxide layer with low and high structure areas can be polished using a CMP slurry containing cerium oxide, wherein the silicon dioxide film that is polished can be completely planarized. See, e.g., column 12, lines 13-65 and column 20, line 1 through column 23, line 33 and Figures 19 E and 19 F of Kodera. As readily apparent from a complete reading of Kodera, the high structure areas are polished

[1]Also, see the current regulation as to separate claim arguments as set forth in 37 CFR § 41.37(c)(1)(vii) (September 13, 2004).

at a higher rate than the low structure areas such that the planarization described is achieved. Kodera does not describe using a dummy structure[2] in the embodiment depicted in Figures 19 E and 19 F, which is consistent with the dummy structure exclusion of claim 1.

Moreover, Kodera teaches that other appropriate materials may be employed in the cerium oxide polishing slurry and that the use of a cerium oxide polishing slurry in accordance with the method depicted in Figures 19 E and 19 F, as described in the specification, results in solving problems earlier identified in the specification. See column 23, lines 1-33 of Kodera. Given that disclosure of Kodera and the teachings of Grover and Burke with respect to using other additives including dispersion aids in a CMP slurry employing cerium oxide, we agree with the examiner (answer, page 8) that it would have been obvious to one of ordinary skill in the art at the time of the invention to employ a slurry modifier in the CMP slurry of Kodera. In this regard, Grover teaches using additives such as other abrasives, acids and surface active dispersing agents and Burke teaches that adding a surfactant or suspension agent, including ethylene

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[2] Appellant defines a dummy structure as structures that "are used for the sole purpose of controlling the CMP rate" (specification, page 1, lines 14-16).

glycol, is beneficial in such a CMP slurry in improving colloidal behavior and reducing or inhibiting the growth and/or coalescence of particles in the slurry. See, e.g., column 3, lines 13-26, column 4, lines 18-29 and column 6, lines 8-64 of Grover and column 3, lines 32-39 and column 3, line 61 through column 4, line 13 of Burke.

Furthermore, we agree with the examiner that the polishing step of Kodera employing such a modified cerium oxide slurry would have obviously resulted in Kodera employing high and low area removal rates corresponding to the claimed rates upon routine experimentation to determine the workable operating parameters for the polishing given that substantially the same polishing slurry is being used in a substantially similar way to achieve substantially the same object of planarization of a silicon dioxide layer including high and low structure areas during a semiconductor CMP polishing step by both appellant and Kodera. See In re Best, 562 F.2d 1252, 1255, 195 USPQ 430, 433-34 (CCPA 1977).

With further regard to this matter, we note that representative claim 1 calls for polishing rates such that low structure areas are polished at a substantially zero rate and high structure areas are polished at a rate approximating the

blanket polishing rate.[3] Concerning those claimed polishing rates, we note that each of those claimed rate terms employ a term of degree ("substantially" or "approximating"), which terms thus encompass a range of polishing (silicon dioxide layer high and low structure area removal) rates. In this regard, appellant's specification furnishes graphs and descriptions thereof that reasonably make clear those claimed rate ranges encompass rates significantly different than either a zero removal rate or a blanket removal rate, respectively. For example, at page 5, line 2 through page 7, line 13, appellant's specification provides that (underlining supplied):

> If polishing using ceria slurry is carried out for a sufficiently long time, two important results occur: First, when the substrate surface becomes substantially planarized, polishing characteristics revert back to more conventional behavior. Second, if silicon, polysilicon, or silicon nitride underlie the polished layer of silicon dioxide, they tend to act as a polish stop. These results are illustrated in FIGS. 6a-6d, which depict polishing characteristics for feature size scales corresponding to FIGS. 3 and 5. Long term ceria polishing characteristics are illustrated generally at 60. A high area rate 62 approximates blanket rate 20 over time, while a low area rate 64 is close to zero. Convergence points 66 are reached in some instances, with a converged rate 68 being shown for those instances. Where an appropriate underlying material is present, a polish stop rate 70 is shown.

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[3] A blanket polishing rate is defined in appellant's specification as a removal rate that is obtained (measured) on an unpatterned waiver. See page 2, line 23 of appellant's specification.

Further testing has demonstrated that addition of a modifier to ceria slurry, in particular ethylene glycol, causes the polishing characteristics illustrated in FIGS. 4, 5 and 6 to become more conventional, as illustrated in FIGS. 2 and 3. This characteristic is shown generally at 80 in FIG. 7, which illustrates the effect of addition of 10% (FIG. 7a) and 20% (FIG. 7b) ethylene glycol, and a down pressure of 6 psi.. A high area rate 82 is approximately the same as blanket rate 20, while a low area rate 84 remains close to zero. Characteristics 82a, 84a, represent a feature size scale of 2x2 μm; characteristics 82b, 84b, represent a feature size scale of 4x4 μm; characteristics 82c, 84c, represent a feature size scale of 8x8 μm; and characteristics 82d, 84d, represent a feature size scale of 16x16 μm. A convergence point 86 is depicted, but not really achieved in the depicted results. Longer polishing times result in the desired convergence and planarization.

A 10%, by volume, addition of ethylene glycol results in the polishing rate of high areas and the blanket polishing rate to be nearly equal. In comparison, for addition of 20% ethylene glycol by volume, the removal rate has fallen below the blanket polish rate. This is similar to conventional behavior. As expected, control wafers polished in slurry with no ethylene glycol modifier show the usual behavior. Ethylene glycol concentrations up to 50% may be used.

The effect of the modifier can be offset by increasing down force. The effect of a 50% increase in down force, to 9 psi, for a 20% by volume addition of ethylene glycol to ceria slurry is shown in FIG. 8, at 90. A high area rate 92, low area rate 94 and convergence point 96 are depicted, with the characteristics being as described in connection with FIG. 7. The preferred modifier is ethylene glycol, however, other modifiers may work as well provided that they alter physical properties of the slurry in the desired way. The modifier may either be pre-mixed in the slurry feedstock or introduced directly to the polishing table to be mixed with slurry during processing. Ideally, the modifier does not participate in the slurry chemistry, but, only affects slurry physical characteristics, i.e., viscosity, surface tension, etc. or concomitantly, effective slurry layer thickness during

the polishing process.

The ideal polishing characteristic of FIG. 1 implies that all pattern dependence may be eliminated because, regardless of size or density, high structure areas polish at the same rate as a flat blanket wafer. Therefore, as the invention is implemented in conjunction with a judicious choice of polishing parameters such as down force, etc., the polishing characteristics of FIG. 1 may be closely approximated. When practicing the preferred embodiment of the invention, a down force of five to ten psi is applied. A table rotation rate of about 20 to 100 rpm is established, as is a spindle rotation rate of about 20 to 100 rpm. A slurry flow rate of 0.50 to 500 ml/min. is maintained.

In a more universal sense, the method of the invention may be used for general global planarization. Use of this method will increase process margin and reduce or eliminate the need to include dummy structures in circuit layouts.

Although a preferred embodiment of the method of the invention has been disclosed herein, it will be appreciated that further variations and modification may be made thereto without departing from the scope of the invention as defined in the appended claims.

Looking at appellant's Figures 7(A) and 7(B) (copy attached to the brief), for example, the low area rate 84 (a-d) is described by appellant as being close to zero not withstanding that the graph depicts that 1,000 angstroms of the low areas of the oxide surface polished is removed prior to a convergence point being reached during the polishing operation (see, e.g., label 84d in Figure 7A). Likewise in appellant's Figure 8, label 94d suggests that nearly 2,000 angstroms of the low areas of the oxide surface that is polished is removed prior to a convergence

point being reached. Yet, appellant recognizes that graph as depicting a low area removal rate consistent with the disclosed invention (involving a substantially zero rate of removal of the low area structure). Consequently, we interpret the claimed "substantially zero" rate of removal of the low structure areas of the oxide layer to include rates of removal that are significant but low relative to the rate of removal of the high structure area removal rate such that a convergence point (planarization) is reasonably achieved.[4] In like fashion, our review of appellant's drawing figures lead us to the conclusion that the claim term "approximating the blanket polishing rate" is inclusive of polishing rates that deviate significantly from a blanket polishing rate so long as those rates are relatively high as compared to the rate at which the low structures of the oxide layer is removed during polishing such that planarization is obtained without using a so-called "dummy structure".[5]

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[4] After all, it is well settled that claim terms are given their broadest reasonable meaning consistent with the specification during examination proceedings before the U.S. Patent and Trademark Office. In this regard, appellant's claims clearly are not limited to high and low area polish removal rates as depicted in the idealized graph of appellant's drawing figure 1.

[5] Those claimed rate terms involve some ambiguity as a result of appellant's use of terms of degree in claiming the polishing rates without appellant having particularly defined or having specified a particular way of assessing the meets and boundaries of those terms of degree in the specification, as

Consequently, we are in full agreement with the examiner's obviousness determination of the subject matter of representative claim 1 over the combined teachings of the applied prior art.

In light of the above discussion, appellant's arguments concerning a lack of suggestion of the claimed subject matter in the applied references is not persuasive. Concerning the examiner's combination of Grover and Burke with Kodera, we note that the applied prior art need not disclose the same function for the modified slurry composition that is employed as that disclosed by appellant for the prior art to render the use of a slurry composition, as claimed, obvious within the meaning of § 103(a). See, e.g., In re Kemps, 97 F.3d 1427, 1430, 40 USPQ2d 1309, 1311 (Fed. Cir. 1996). In this regard, we again note that Kodera teaches that other appropriate materials may be employed

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filed. Nevertheless, for reasons stated above, we determine that the merits of the examiner's obviousness rejection can be assessed by giving those claim terms a reasonable conditional claim interpretation based on their broadest reasonable meaning in light of appellant's drawing figure representations, as discussed above. However, in the event of further prosecution of this subject matter before the examiner, the examiner should determine whether or not the claims are compliant with the second paragraph of § 112 in light of those terms of degree as employed in the claims. After all, a principal purpose of the second paragraph of § 112 is to provide those who would endeavor, in future enterprises, to approach the area circumscribed by the claims of a patent, with adequate notice demanded by due process of law, so that they may more readily and accurately determine the boundaries of protection involved and evaluate the possibility of infringement and dominance. See In re Hammack, 427 F.2d 1378, 1382, 166 USPQ 204, 208 (CCPA 1970).

in the cerium oxide polishing slurry and that the use of a cerium oxide polishing slurry in accordance with the method depicted in Figures 19 E and 19 F, as described in the specification, results in solving problems earlier identified in the specification. See column 23, lines 1-33 of Kodera.

One of those earlier noted problems is a problem with conducting a polishing operation such that the rate of removal of the raised portions of the silicon dioxide layer is significantly greater than the rate of removal of the lower portions of the silicon dioxide layer during polishing such that planarization is achieved without using inordinately thick silicon dioxide layers. Another problem discussed in Kodera relates to a so-called dishing phenomena. See, e.g., column 3, lines 4-24 and column 3, line 42 through column 4, line 6 of Kodera. Those problems, which are discussed with respect to prior art polishing methods, are addressed by the inventive methods discussed in Kodera. See, e.g., column 12, lines 13-65 and the above-noted portion of column 23 of Kodera. Accordingly, we do not find appellant's arguments related to dishing problems as presented in the reply brief, and the asserted lack of a suggestion of the claimed relatively high removal rate for the raised portion of the silicon dioxide layer relative to lower portions of that layer to be persuasive.

With regard to representative claim 4 and appellant's second claim grouping, appellant also maintains that the ethylene glycol component of the polishing slurry, as required by that claim is not suggested by the combined teachings of the references. However, for reasons set forth above and in the answer, we disagree. The use of slurry modifiers including a dispersing or suspension agent, such as ethylene glycol is clearly suggested by the teachings of those combined references so as to aid in the dispersion of the cerium oxide and any other abrasive particles in the polishing slurry. One of ordinary skill in the art would have readily determined the workable and optimum amounts of such a result effective suspension agent to be used in the polishing slurry upon routine experimentation. Consequently, those additional arguments do not overcome the examiner's obviousness rejection of the second group of claims.

Concerning representative claim 13 of appellant's third claim grouping, we recognize that a substantially zero polishing rate for low structures is not required therein albeit an approximately blanket rate of polishing the high structure areas is required. For reasons stated above and in the answer, we find that high structure polishing rate as called for in representative claim 13 obvious to one of ordinary skill in the art at the time of the invention. As for the additional claim

requirement that the high structure polishing removal rate of the slurry would be less than the blanket rate prior to adding a slurry modifier, such as ethylene glycol, we note that it is reasonable to expect that the cerium oxide slurry of Kodera would have a substantially similar rate prior to adding ethylene glycol as a dispersing agent given the commonalities thereof to the CMP slurry of appellant. It is well settled that in a case such as this where appellant is asserting a functional property for a slurry that is alleged to be not possessed by a prior art slurry that appears to comparable to that of appellant, it is appropriate that the burden is shifted to appellant to show that the prior art slurry would not, in fact, possess the property in question. Here, appellant has not undertaken, much less discharged, that burden. It follows that we will also sustain the examiner's obviousness rejection of the third claim grouping.

Regarding the fourth multiple claim grouping (Issue No. 5) and representative claim 17, appellant acknowledges that Kodera seemingly discloses a low density high structure polishing rate that is essentially the same as a high density high structure polishing rate, as required by claim 17, albeit in so doing Kodera employs a dummy structure (stopper layer), which is excluded by the representative claim, as argued by appellant.

As explained at the bottom of page 6 of appellant's specification, approaching the ideal polishing characteristics as depicted in Figure 1 (blanket polishing rate of high structure areas) results in such a pattern independent polishing rate, that is, a rate that is the same for high and low density high structure areas. Because we have found that the applied prior art would have reasonably suggested using a CMP slurry having the property of allowing for polishing rates for the high structure areas that approximate the blanket polishing rate for reasons discussed above, we also find that the argued characteristic of the CMP slurry of claim 17 would also reasonably have been expected to result from employing a modified slurry as suggested by the applied references for the Figure 19 embodiment of Kodera. Moreover, as far as the polysilicon layer 203 and the amorphous silicon film 233A of Kodera in other embodiments thereof as referred to at page 13 of appellant's brief are concerned, we do not consider those layers to be a dummy structure as excluded by representative claim 17. In this regard and as we reported in footnote 2 above, appellant defines a dummy structure as a structure that is used for the sole purpose of controlling the CMP rate. Kodera, however, employs the polysilicon layer 203 for the electrical conductivity thereof and only selectively removes same; that is, removes portions thereof. See column 27, lines 5-

11 of Kodera. Also, Kodera employs the amorphous silicon film 233A to form another insulating layer therefrom. See column 30, lines 15-19 of Kodera. Consequently, Kodera also reasonably appears to suggest the process of representative claim 17 in those other embodiments, as seemingly acknowledged by appellant but for the dummy structure argument, which we do not find persuasive.

Concerning claim 15, appellant maintains that the combined references' teachings would not suggest using ethylene glycol for the purposes identified by appellant. However, for reasons discussed above, the collective teachings of the references do suggest using ethylene glycol in the polishing slurry of Kodera as a dispersing agent and appellant has not persuasively rebutted that position of the examiner. As noted above, the rationale provided by the collective teachings of the applied references for making a particular modification of a reference need not be the same as that disclosed by appellant for the modification to be obvious within the meaning of § 103.

Finally, with regard to claim 20, appellant presents a similar argument regarding the obviousness of adding ethylene glycol to the slurry of Kodera. For the reasons advanced above, we again reiterate that the direction to the claimed invention suggested by the prior art need not be by way of the same

motivating force as appellant may disclose for their invention. Rather, the applied references, as is the case here, can make out a sustainable case of obviousness premised on one of ordinary skill in the art being led to subject matter corresponding to the claimed subject matter for reasons distinctly different than reasons that appellant may have developed.

It follows that, on this record, we will sustain the examiner's obviousness rejection of the appealed claims.

CONCLUSION

The decision of the examiner to reject claims 1-20 under 35 U.S.C. § 103(a) as being unpatentable over Kodera in view of Grover and Burke is affirmed.

CONCLUSION

The decision of the examiner to reject claims 1-20 under 35 U.S.C. § 103(a) as being unpatentable over Kodera in view of Grover and Burke is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR § 1.136(a).

AFFIRMED

EDWARD C. KIMLIN
Administrative Patent Judge

THOMAS A. WALTZ
Administrative Patent Judge

PETER F. KRATZ
Administrative Patent Judge

BOARD OF PATENT APPEALS AND INTERFERENCES

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